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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/828,441	04/20/2004	Li-Qun Xia	AMAT/6392.C1/DSM/LOW K/JW	4006
44257	7590	11/08/2005	EXAMINER NGUYEN, HA T	
PATTERSON & SHERIDAN, LLP 3040 POST OAK BOULEVARD, SUITE 1500 HOUSTON, TX 77056			ART UNIT 2812	PAPER NUMBER

DATE MAILED: 11/08/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/828,441

Applicant(s)

XIA ET AL.

Examiner

Ha T. Nguyen

Art Unit

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 22 August 2005.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 26-28,30,35-37,39,41 and 46-61 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 46-50 is/are allowed.
- 6) ☒ Claim(s) 26-28,30,35-37,39,41 and 51-61 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date <u>4-18-12-5</u> | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Notice to applicant

1. Applicants' Amendment and Response to the Office Action mailed 05-20-2005 and Request for a Continued Examination have been entered and made of record. Following is an Office Action responding to the request.

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless --

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

3. Claims 57-59 are rejected under 35 U.S.C. 102(e) as being anticipated by Chooi et al. (USPN 6436824, hereinafter "Chooi").

Referring to Figs. 1-3 and related text, Chooi discloses [Re claims 57 and 59] a method for depositing a silicon carbide layer on a substrate, comprising: introducing a processing gas comprising an organosilicon compound into a processing chamber containing the substrate therein; and reacting the organosilicon compound to deposit the silicon carbide layer on the substrate wherein the organosilicon compound has the formula $\text{SiHa}(\text{CH}_3)_b(\text{C}_6\text{H}_5)_c$, wherein c is 1 and $a+b+c=4$; wherein the organosilicon compound comprises dimethylphenylsilane (see col. 3, lines 9-col. 4, line 10, especially col. 3, line 53);

[Re claim 58] wherein the processing gas further comprises a dopant selected from the group consisting of an oxygen-containing compound, a nitrogen-containing compound... (see col. 4, lines 19-29).

Claim Rejections - 35 USC 103

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4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103 and potential 35 U.S.C. 102(f) or (g) prior art under 35 U.S.C. 103(a).

5. Claims 26, 35-37, 60- 61 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chooi or Laxman et al. (USPAPN 2002/0172766, hereinafter "Laxman").

Referring to Figs. 1-3 and related text, Chooi discloses [Re claim 26] a method for depositing a silicon carbide layer on a substrate, comprising: introducing a processing gas comprising an organosilicon compound and a dopant compound into a processing chamber containing the substrate therein (see embodiments 1-3], wherein the organosilicon compound consists essentially of silicon, carbon, and hydrogen, and has a carbon atom to silicon atom ratio of 6:1 or greater (see col. 3, lines 33-60); and reacting the organosilicon compound to form the silicon carbide layer having a dielectric constant in the range of 3-6.5, wherein the dopant compound is selected from the group consisting of an oxygen-containing compound,... (see col. 3, lines 33-col. 4, line 29); [Re claims 35-37] a method for processing a substrate having metal 14 therein, comprising: depositing a barrier layer 16 on the substrate on the metal features by introducing a processing gas comprising an organosilicon compound into a processing chamber containing the substrate therein, wherein the organosilicon compound consists essentially of silicon, carbon, and hydrogen, and has a carbon atom to silicon atom ratio of about 6:1 or greater

and the barrier layer has a dielectric constant in the range of 3-6.5; and the dopant compound is selected from the group consisting of an oxygen-containing compound,... and depositing a first dielectric layer adjacent the barrier layer, wherein the first dielectric layer 18 comprises silicon, oxygen, and carbon and has a dielectric constant of about 3 or less, as shown above; depositing a silicon carbide etch stop 20 on the first dielectric layer (see col. 3, line 45-col. 5, line 10). But it does not disclose expressly all the limitations in the same process and the generating a plasma of the processing gas and the claimed ranges. However, it would have been obvious to an ordinary artisan to use the disclosed features in the same process to obtain device meeting the requirements of a specific application. Besides, in a PECVD process, the process gas enter into a reaction in the energized ionized state, a plasma, it is inherent that the step of generating the plasma exists, and in the case where the claimed ranges “overlap or lie inside ranges disclosed by the prior art” a *prima facie* case of obviousness exists (See MPEP 2144.05).

[Re claim 60] Chooi also discloses wherein the silicon carbide layer is deposited in a damascene structure as a material layer selected from the group consisting of a silicon carbide-containing barrier layer and a silicon carbide-containing etch top layer (see col. 3, lines 9-col. 4, line 10). But it does not disclose expressly all the features in the same process. However, it would have been obvious to an ordinary artisan to modify Chooi’ s teaching to obtain devices meeting the requirements of a specific applications;

[Re claim 61] wherein the silicon carbide layer has a dielectric constant of between about 3 to 6.5. But it does not disclose expressly a value of less than 4. However, in the case where the claimed ranges “overlap or lie inside ranges disclosed by the prior art” a *prima facie* case of obviousness exists. In re Wertheim, 541 F. 2d 257, 191 USPQ 90 (CCPA 1976); In re Woodruff, 919 F. 2d 1575, 16 USPQ 2d 1934 (Fed. Cir. 1990).

[Re claims 26-27] Laxman discloses a method for depositing a silicon carbide layer on a substrate, comprising: introducing a processing gas comprising an organosilicon compound and a dopant compound into a processing chamber containing the substrate therein, wherein the organosilicon compound consists essentially of silicon, carbon, and hydrogen, and has a carbon atom to silicon atom ratio of 6:1 or greater (see par. 67 and 87); and reacting the organosilicon compound to form the silicon carbide layer having a dielectric constant less than 3, wherein the dopant compound is selected from the group consisting of an oxygen-containing compound,

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O2...(see pars. 76-84, 87, and 89). But it does not disclose expressly all the limitations in the same process and the claimed ranges. However, it would have been obvious to an ordinary artisan to use the disclosed features in the same process to obtain device meeting the requirements of a specific application. Besides, in the case where the claimed ranges “overlap or lie inside ranges disclosed by the prior art” a *prima facie* case of obviousness exists (See MPEP 2144.05).

[Re claim 28] Laxman discloses exposing the silicon carbide layer to a plasma treatment process (see par. 101).

6. Claims 27-28, 30, 39, and 41 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chooi in view of Xia et al. (EP 1050601, hereinafter “Xia”).

[Re claim 27] Chooi discloses substantially the limitations of claim 27, as shown above. But it fails to disclose expressly the claimed dopant compound. However, Xia discloses this feature (see par. 72). At the time of the invention, an ordinary artisan is motivated to combine Chooi with Xia to reduce metal contamination (see par. 72).

[Re claims 28 and 39] Xia also discloses exposing the silicon carbide layer to a plasma treatment process (see par. 79).

[Re claim 30] The combined teaching of Chooi and Xia does not teach wherein the ratio of dopant compound to organosilicon compound comprises between about 1:5 and about 1:100. However any variation in reactants ratio in the present claim is obvious in light of the cited art, because the changes in reactants ratio produce no unexpected function.

The routine varying of parameters to produce expected changes are within the ability of one of ordinary skill in the art. Patentability over the prior art will only occur if the parameter variation produces an unexpected result. In re Aller, Lacey and Hall, 105 U.S.P.Q. 233, 235. In re Reese 129 U.S.P.Q. 402, 406.

[Re claim 41] Xia also discloses wherein the dopant compound selected from the group consisting of phosphine, borane, diborane, trimethylsilane, oxygen, ozone, CO, CO₂, and combination thereof (see par. 72).

Therefore, it would have been obvious to combine Chooi with Xia to obtain the invention as specified in claims 27-28, 30, 39, and 41.

7. Claims 51-56 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chooi in view of Xia and Yang et al. (USPN 6365527, hereinafter "Yang").

[Re claim 51] the combined teaching of Chooi and Xia discloses a method for depositing a silicon carbide layer on a substrate, comprising: introducing a processing gas comprising an oxygen-containing compound, a dopant, and an organosilicon compound that consists essentially of silicon, carbon, and hydrogen, and has a carbon atom to silicon ratio of 6:1 or greater to carbide layer on the substrate; reacting the organosilicon compound by a PECVD process to deposit the silicon carbide layer on the substrate, wherein the dopant compound is selected from the claimed group; [Re claim 52] exposing the silicon carbide layer to a plasma treatment process; [Re claim 53] wherein the dopant is selected from the group consisting of phosphine (PH₃), borane (BH₃), diborane (B₂H₆), and combinations thereof, as shown above. But it fails to disclose wherein the silicon carbide layer comprises less than about 15 atomic percent of oxygen and exposing the deposited silicon carbide layer to a plasma treatment process. However, the missing limitations are well known in the art because Yang discloses these features (col. 3, lines 34-45). At the time of the invention, an ordinary artisan is motivated to combine Chooi and Xia with Yang to reduce oxygen content in the silicon carbide for use in oxygen-sensitive process.

[Re claim 54] Chooi discloses that wherein the silicon carbide layer has a dielectric constant of less than 4 (see col. 4, lines 1-29);

[Re claim 55] wherein the silicon carbide layer is deposited in a damascene structure as a material layer selected from the group consisting of a silicon carbide-containing barrier layer and a silicon carbide-containing etch stop layer (see Fig. 2); and

[Re claim 56] depositing a dielectric layer 22 adjacent the silicon carbide layer.

Therefore, it would have been obvious to combine Chooi and Xia with Yang to obtain the invention as specified in claims 51-56.

Allowable Subject Matter

8. Claims 46-50 are allowed.

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Claim 46 recites wherein the organosilicon compound has the formula $\text{SiHa}(\text{CH}_3)_b(\text{C}_6\text{H}_5)_c$, wherein c is 2 and $a+b+c = 4$.

This features in combination with the other elements of the claim is neither disclosed nor suggested by the prior art of record.

Claims 47-50 variously depend from claim 46, they are allowed for the same reason.

Response to Amendment

9. In view of applicants' filing of a Terminal Disclaimer on 6-7-5, the Double Patenting rejection of claims 46, 48, and 50 has been withdrawn.

In view of applicants' arguments and amendments to the claims, the rejections of claims 26-28, 30, 35-37, 39, 41, 51-56, as stated in the immediately preceding Office Action have been modified or withdrawn. Applicants are referred to the modified or new grounds of rejection, given above.

Applicant's arguments with regard to the rejections under 35 U.S.C. 103 have been fully considered, but they are not deemed to be persuasive for at least the following reasons.

Applicants argued that Chooi cannot be combined with Xia because Chooi discloses a PECVD while Xia discloses a thermal CVD, the examiner disagreed. Xia does not only use thermal CVD in a PECVD chamber but Xia also disclose the use of a combination of a thermal and a PECVD (see par. 75). Besides, both processes are CVD processes involving reactions between gaseous reactants. Therefore, they are combinable. In the combined teaching of Chooi and Xia, the gaseous reactants including organosilicon compound (s) and dopant compound are introduced in the process chamber.

Conclusion

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ha T. Nguyen whose telephone number is (571) 272-1678. The examiner can normally be reached on Monday-Friday from 8:30AM to 6:00PM, except the first Friday of each bi-week. The telephone number for Wednesday is (703) 560-0528.

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If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael S. Lebentritt, can be reached on (571) 272-1873. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



Ha Tran Nguyen
Primary Examiner
10- 27- 05